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EDUCATION

CHEMISTRY CONSTANTS

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NAMES, FORMULAS, AND CHARGES OF SOME COMMON IONS

POSITIVE IONS (CATIONS)		NEGATIVE IONS (ANIONS)	
aluminum	Al^{+3}	acetate	CH_3COO^-
ammonium	NH_4^+	bromide	Br^-
barium	Ba^{+2}	carbonate	CO_3^{-2}
calcium	Ca^{+2}	hydrogen carbonate ion, bicarbonate	HCO_3^-
chromium (II), chromous	Cr^{+2}	chlorate	ClO_3^-
chromium (III), chromic	Cr^{+3}	chloride	Cl^-
cobalt (II), cobaltous	Co^{+2}	chlorite	ClO_2^-
copper (I),* cuprous	Cu^+	chromate	CrO_4^{-2}
copper (II), cupric	Cu^{+2}	dichromate	$Cr_2O_7^{-2}$
hydrogen, hydronium	H^+, H_3O^+	fluoride	F^-
iron (II),* ferrous	Fe^{+2}	hydroxide	OH^-
iron (III), ferric	Fe^{+3}	hypochlorite	ClO^-
lead	Pb^{+2}	iodide	I^-
lithium	Li^+	nitrate	NO_3^-
magnesium	Mg^{+2}	nitrite	NO_2^-
manganese (II), manganous	Mn^{+2}	oxalate	$C_2O_4^{-2}$
mercury (I),* mercurous	Hg_2^{+2}	hydrogen oxalate ion, binoxalate	$HC_2O_4^-$
mercury (II), mercuric	Hg^{+2}	perchlorate	ClO_4^-
potassium	K^+	permanganate	MnO_4^-
silver	Ag^+	phosphate	PO_4^{-3}
sodium	Na^+	monohydrogen phosphate	HPO_4^{-2}
strontium	Sr^{+2}	dihydrogen phosphate	$H_2PO_4^-$
tin (II),* stannous	Sn^{+2}	sulfate	SO_4^{-2}
tin (IV), stannic	Sn^{+4}	hydrogen sulfate ion, bisulfate	HSO_4^-
zinc	Zn^{+2}	sulfide	S^{-2}
		hydrogen sulfide ion, bisulfide	HS^-
		sulfite	SO_3^{-2}
		hydrogen sulfite ion, bisulfite	HSO_3^-

*Aqueous solutions are readily oxidized by air.

NOTE: In ionic compounds the relative number of positive and negative ions is such that the sum of their electric charges is zero.

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INTERNATIONAL ATOMIC WEIGHTS

Name	Symbol	Atomic Number	Atomic Weight
Actinium	Ac	89	(227)
Aluminum	Al	13	27.0
Americium	Am	95	(243)
Antimony	Sb	51	121.8
Argon	Ar	18	39.9
Arsenic	As	33	74.9
Astatine	At	85	(210)
Barium	Ba	56	137.3
Berkelium	Bk	97	245
Beryllium	Be	4	9.01
Bismuth	Bi	83	209.0
Boron	B	5	10.8
Bromine	Br	35	79.9
Cadmium	Cd	48	112.4
Calcium	Ca	20	40.1
Californium	Cf	98	(251)
Carbon	C	6	12.01
Cerium	Ce	58	140.1
Cesium	Cs	55	132.9
Chlorine	Cl	17	35.5
Chromium	Cr	24	52.0
Cobalt	Co	27	58.9
Copper	Cu	29	63.5
Curium	Cm	96	(247)
Dysprosium	Dy	66	162.5
Einsteinium	Es	99	(254)
Erbium	Er	68	167.3
Europium	Eu	63	152.0
Fermium	Fm	100	(253)
Fluorine	F	9	19.0
Francium	Fr	87	(223)
Gadolinium	Gd	64	157.3
Gallium	Ga	31	69.7
Germanium	Ge	32	72.6
Gold	Au	79	197.0
Hafnium	Hf	72	178.5
Helium	He	2	4.00
Holmium	Ho	67	164.9
Hydrogen	H	1	1.008
Indium	In	49	114.8
Iodine	I	53	126.9
Iridium	Ir	77	192.2
Iron	Fe	26	55.8
Krypton	Kr	36	83.8
Lanthanum	La	57	138.9
Lead	Pb	82	207.2
Lithium	Li	3	6.94
Lutetium	Lu	71	175.0
Magnesium	Mg	12	24.3
Manganese	Mn	25	54.9
Mendelevium	Md	101	(256)
Mercury	Hg	80	200.6
Molybdenum	Mo	42	95.9
Neodymium	Nd	60	144.2
Neon	Ne	10	20.2
Neptunium	Np	93	(237)
Nickel	Ni	28	58.7
Niobium	Nb	41	92.9
Nitrogen	N	7	14.01
Osmium	Os	76	190.2
Oxygen	O	8	16.00
Palladium	Pd	46	106.4
Phosphorus	P	15	31.0
Platinum	Pt	78	195.1
Plutonium	Pu	94	(242)
Polonium	Po	84	210
Potassium	K	19	39.1
Praseodymium	Pr	59	140.9
Promethium	Pm	61	(147)
Protactinium	Pa	91	(231)
Radium	Ra	88	(226)
Radon	Rn	86	(222)
Rhenium	Re	75	186.2
Rhodium	Rh	45	102.9
Rubidium	Rb	37	85.5
Ruthenium	Ru	44	101.1
Samarium	Sm	62	150.4
Scandium	Sc	21	45.0
Selenium	Se	34	79.0
Silicon	Si	14	28.1
Silver	Ag	47	107.9
Sodium	Na	11	23.0
Strontium	Sr	38	87.6
Sulfur	S	16	32.1
Tantalum	Ta	73	180.9
Technetium	Tc	43	(99)
Tellurium	Te	52	127.6
Terbium	Tb	65	158.9
Thallium	Tl	81	204.4
Thorium	Th	90	232.0
Thulium	Tm	69	168.9
Tin	Sn	50	118.7
Titanium	Ti	22	47.9
Tungsten	W	74	183.9
Uranium	U	92	238.0
Vanadium	V	23	50.9
Xenon	Xe	54	131.3
Ytterbium	Yb	70	173.0
Yttrium	Y	39	88.9
Zinc	Zn	30	65.4
Zirconium	Zr	40	91.2

Parenthetical values refer to radioactive elements; the mass number (not the atomic weight) of the isotope with largest half-life is usually given.

*Latest values recommended by the International Union of Applied Chemistry, 1961.

PERIODIC TABLE

PERIOD	GROUP 1A	GROUP 2A	TRANSITION ELEMENTS GROUP 3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	GROUP 3A	GROUP 4A	GROUP 5A	GROUP 6A	GROUP 7A	GROUP 0
1																		2 He 4.0
																		1 H 1.0
2	3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
3	11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
4	19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-71 See La Series	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra (226)	89-103 See Ac Series															

La Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (147)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Ac Series	89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (245)	98 Cf (251)	99 Es (254)	100 Fm (253)	101 Md (256)	102 (254)	103 Lw (257)

Parenthetical values are mass numbers of the isotopes with longest half lives

RELATIVE STRENGTHS OF ACIDS

IN AQUEOUS SOLUTION AT ROOM TEMPERATURE

ALL IONS ARE AQUATED

$$HB \rightleftharpoons H^+(aq) + B^-(aq) \qquad K_A = \frac{[H^+][B^-]}{[HB]}$$

ACID	STRENGTH	REACTION	K_A
perchloric acid	very strong	$HClO_4 \rightarrow H^+ + ClO_4^-$	very large
hydriodic acid	↓	$HI \rightarrow H^+ + I^-$	very large
hydrobromic acid	↓	$HBr \rightarrow H^+ + Br^-$	very large
hydrochloric acid	↓	$HCl \rightarrow H^+ + Cl^-$	very large
nitric acid	↓	$HNO_3 \rightarrow H^+ + NO_3^-$	very large
sulfuric acid	very strong	$H_2SO_4 \rightarrow H^+ + HSO_4^-$	large
oxalic acid	↓	$HOOCCOOH \rightarrow H^+ + HOOCCOO^-$	5.4×10^{-2}
sulfurous acid ($SO_2 + H_2O$)	↓	$H_2SO_3 \rightarrow H^+ + HSO_3^-$	1.7×10^{-2}
hydrogen sulfate ion	strong	$HSO_4^- \rightarrow H^+ + SO_4^{-2}$	1.3×10^{-2}
phosphoric acid	↓	$H_3PO_4 \rightarrow H^+ + H_2PO_4^-$	7.1×10^{-3}
ferric ion	↓	$Fe(H_2O)_6^{+3} \rightarrow H^+ + Fe(H_2O)_5(OH)^{+2}$	6.0×10^{-3}
hydrogen telluride	↓	$H_2Te \rightarrow H^+ + HTe^-$	2.3×10^{-3}
hydrofluoric acid	weak	$HF \rightarrow H^+ + F^-$	6.7×10^{-4}
nitrous acid	↓	$HNO_2 \rightarrow H^+ + NO_2^-$	5.1×10^{-4}
hydrogen selenide	↓	$H_2Se \rightarrow H^+ + HSe^-$	1.7×10^{-4}
chromic ion	↓	$Cr(H_2O)_6^{+3} \rightarrow H^+ + Cr(H_2O)_5(OH)^{+2}$	1.5×10^{-4}
benzoic acid	↓	$C_6H_5COOH \rightarrow H^+ + C_6H_5COO^-$	6.6×10^{-5}
hydrogen oxalate ion	↓	$HOOCCOO^- \rightarrow H^+ + OOCCOO^{-2}$	5.4×10^{-5}
acetic acid	weak	$CH_3COOH \rightarrow H^+ + CH_3COO^-$	1.8×10^{-5}
aluminum ion	↓	$Al(H_2O)_6^{+3} \rightarrow H^+ + Al(H_2O)_5(OH)^{+2}$	1.4×10^{-5}
carbonic acid ($CO_2 + H_2O$)	↓	$H_2CO_3 \rightarrow H^+ + HCO_3^-$	4.4×10^{-7}
hydrogen sulfide	↓	$H_2S \rightarrow H^+ + HS^-$	1.0×10^{-7}
dihydrogen phosphate ion	↓	$H_2PO_4^- \rightarrow H^+ + HPO_4^{-2}$	6.3×10^{-8}
hydrogen sulfite ion	↓	$HSO_3^- \rightarrow H^+ + SO_3^{-2}$	6.2×10^{-8}
ammonium ion	weak	$NH_4^+ \rightarrow H^+ + NH_3$	5.7×10^{-10}
hydrogen carbonate ion	↓	$HCO_3^- \rightarrow H^+ + CO_3^{-2}$	4.7×10^{-11}
hydrogen telluride ion	↓	$HTe^- \rightarrow H^+ + Te^{-2}$	1.0×10^{-11}
hydrogen peroxide	very weak	$H_2O_2 \rightarrow H^+ + HO_2^-$	2.4×10^{-12}
monohydrogen phosphate ion	↓	$HPO_4^{-2} \rightarrow H^+ + PO_4^{-3}$	4.4×10^{-13}
hydrogen sulfide ion	↓	$HS^- \rightarrow H^+ + S^{-2}$	1.3×10^{-13}
water	↓	$H_2O \rightarrow H^+ + OH^- \quad [H^+][OH^-] = 1.0 \times 10^{-14}$	
hydroxide ion	↓	$OH^- \rightarrow H^+ + O^{-2}$	$< 10^{-36}$
ammonia	very weak	$NH_3 \rightarrow H^+ + NH_2^-$	very small

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VAPOR PRESSURE OF WATER

Temp., °C.	Pressure mm. Hg	Temp., °C.	Pressure mm. Hg
0	4.6	23	21.1
1	4.9	24	22.4
2	5.3	25	23.8
3	5.7	26	25.2
4	6.1	27	26.7
5	6.5	28	28.3
6	7.0	29	30.0
7	7.5	30	31.8
8	8.0	35	42.2
9	8.6	40	55.3
10	9.2	45	71.9
11	9.8	50	92.5
12	10.5	55	118.0
13	11.2	60	149.4
14	12.0	65	187.5
15	12.8	70	233.7
16	13.6	75	289.1
17	14.5	80	355.1
18	15.5	85	433.6
19	16.5	90	525.8
20	17.5	95	633.9
21	18.7	100	760.0
22	19.8	105	906.1

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ENTHALPY OF FORMATION

$\triangle H_f$ = heat of formation of the given substance from its elements. All values of $\triangle H_f$ are expressed as Kcal mole^{-1} at 25°C. Negative values of $\triangle H_f$ indicate exothermic reactions. State of substance: s = solid, *l* = liquid, g = gaseous.

Substance	$\triangle H_f$	Substance	$\triangle H_f$
Aluminum oxide, Al_2O_3(s)	—399.09	Iron (II, III) oxide, Fe_3O_4(s)	—267.0
Ammonia, NH_3(g)	—11.04	Iron (III) oxide, Fe_2O_3(s)	—196.5
Barium sulphate, $BaSO_4$(s)	—350.2	Lead (II) oxide, PbO(s)	—52.07
Benzene, C_6H_6(g)	+19.82	Lead (II) Nitrate, $Pb(NO_3)_2$(s)	—107.35
Benzene, C_6H_6(*l*)	+11.72	Lead (II) sulphide, PbS(s)	—22.54
Calcium chloride, $CaCl_2$(s)	—190.0	Magnesium chloride, $MgCl_2$(s)	—153.40
Calcium hydroxide, $Ca(OH)_2$(s)	—235.80	Magnesium oxide, MgO(s)	—143.84
Calcium oxide, CaO(s)	—151.9	Mercury (II) chloride, $HgCl_2$(s)	—55.0
Carbon (diamond), C(s)	+0.45	Mercury (II) fulminate, $HgC_2N_2O_2$(s)	—64.52
Carbon (graphite), C(s)	0.00	Mercury (II) nitrate, $Hg(NO_3)$(s)	—93.0
Carbon dioxide, CO_2(g)	—94.05	Mercury (II) oxide, HgO(s)	—21.68
Carbon disulphide, CS_2(g)	+27.55	Methane, CH_4(g)	—17.89
Carbon disulphide, CS_2(*l*)	+21.0	Nitrogen dioxide, NO_2(g)	+8.09
Carbon monoxide, CO(g)	—26.42	Nitrogen monoxide, NO(g)	+21.60
Carbon tetrachloride, CCl_4(g)	—25.5	Oxygen, O_2(g)	0.00
Carbon tetrachloride, CCl_4(*l*)	—33.3	Ozone, O_3(g)	+34.00
Copper (II) nitrate, $Cu(NO_3)_2$(s)	—73.4	Potassium bromide, KBr(s)	—93.73
Copper (II) oxide, CuO(s)	—37.1	Potassium chloride, KCl(s)	—104.18
Copper (II) sulphate, $CuSO_4$(s)	—184.00	Potassium hydroxide, KOH(s)	—101.78
Dinitrogen monoxide, N_2O(g)	+19.49	Potassium nitrate, KNO_3(s)	—117.76
Dinitrogen pentoxide, N_2O_5(g)	+3.6	Potassium sulphate, K_2SO_4(s)	—342.66
Dinitrogen pentoxide, N_2O_5(s)	—10.0	Silver chloride, AgCl(s)	—30.36
Dinitrogen tetroxide, N_2O_4(g)	+2.31	Silver nitrate, $AgNO_3$(s)	—29.43
Diphosphorus pentoxide, P_2O_5(s)	—360.0	Silver sulphide, Ag_2S(s)	—7.60
Ethyne (acetylene), C_2H_2(g)	+54.19	Sodium bromide, NaBr(s)	—86.03
Hydrogen, H_2(g)	0.00	Sodium chloride, NaCl(s)	—98.23
Hydrogen bromide, HBr(g)	—8.66	Sodium hydroxide, NaOH(s)	—101.99
Hydrogen chloride, HCl(g)	—22.06	Sodium nitrate, $NaNO_3$(s)	—101.54
Hydrogen fluoride, HF(g)	—64.2	Sodium sulphate, Na_2SO_4(s)	—330.90
Hydrogen iodide, HI(g)	+6.20	Sulphur dioxide, SO_2(g)	—70.96
Hydrogen oxide (water), H_2O(g)	—57.80	Sulphur trioxide, SO_3(g)	—94.45
Hydrogen oxide (water), H_2O(*l*)	—68.32	Tin (IV) chloride, $SnCl_4$(*l*)	—130.3
Hydrogen peroxide, H_2O_2(g)	—31.83	Zinc nitrate, $Zn(NO_3)_2$(s)	—115.12
Hydrogen peroxide, H_2O_2(*l*)	—44.84	Zinc oxide, ZnO(s)	—83.17
Hydrogen sulphide, H_2S(g)	—4.82	Zinc sulphate, $ZnSO_4$(s)	—233.88
Iron (II) sulphate, $FeSO_4$(s)	—220.5	Zinc sulphide, ZnS(s)	—14.0

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SOLUBILITY OF COMMON COMPOUNDS IN WATER

Negative Ions (Anions)	+	Positive Ions (Cations)	Form	Compounds With Solubility
All		Alkali ions Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+		Soluble
All		Hydrogen ion, $H^+(aq)$		Soluble
All		Ammonium ion, NH_4^+		Soluble
Nitrate, NO_3^-		All		Soluble
Acetate, CH_3COO^-		All		Soluble
Chloride, Cl^- Bromide, Br^- Iodide, I^-		Ag^+, Pb^{+2}, Hg_2^{+2}, Ba^{+2}, Pb^{+2}		Low Solubility
		All others		Soluble
Sulfate, SO_4^{-2}		Ag^+, Ca^{+2}, Sr^{+2}, Ba^{+2}, Pb^{+2}		Low Solubility
		All others		Soluble
Sulfide, S^{-2}		Alkali ions, $H^+(aq)$, NH_4^+, Be^{+2},		Soluble
		Mg^{+2}, Ca^{+2}, Sr^{+2}, Ba^{+2}		Soluble
		All others		Low Solubility
Hydroxide, OH^-		Alkali ions, $H^+(aq)$, NH_4^+, Sr^{+2}, Ba^{+2}		Soluble
		All others		Low Solubility
Phosphate, PO_4^{-3} Carbonate, CO_3^{-2} Sulfite, SO_3^{-2}		Alkali ions, $H^+(aq)$, NH_4^+		Soluble
		All others		Low Solubility

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Solubility products:

$Mg(OH)_2$	8.9×10^{-12}	NiS	3×10^{-21}
MgF_2	8×10^{-8}	PtS	8×10^{-73}
MgC_2O_4	8.6×10^{-5}	$Cu(OH)_2$	1.6×10^{-19}
$Ca(OH)_2$	1.3×10^{-6}	CuS	8×10^{-37}
CaF_2	1.7×10^{-10}	AgCl	1.7×10^{-10}

ELECTRONEGATIVITIES OF THE ELEMENTS

1 H 2.1																	2 He --
3 Li 1.0	4 Be 1.5											5 B 2.0	6 C 2.5	7 N 3.0	8 O 3.5	9 F 4.0	10 Ne --
11 Na 0.9	12 Mg 1.2											13 Al 1.5	14 Si 1.8	15 P 2.1	16 S 2.5	17 Cl 3.0	18 Ar --
19 K 0.8	20 Ca 1.0	21 Sc 1.3	22 Ti 1.5	23 V 1.6	24 Cr 1.6	25 Mn 1.5	26 Fe 1.8	27 Co 1.8	28 Ni 1.8	29 Cu 1.9	30 Zn 1.6	31 Ga 1.6	32 Ge 1.8	33 As 2.0	34 Se 2.4	35 Br 2.8	36 Kr --
37 Rb 0.8	38 Sr 1.0	39 Y 1.2	40 Zr 1.4	41 Nb 1.6	42 Mo 1.8	43 Te 1.9	44 Ru 2.2	45 Rh 2.2	46 Pd 2.2	47 Ag 1.9	48 Cd 1.7	49 In 1.7	50 Sn 1.8	51 Sb 1.9	52 Te 2.1	53 I 2.5	54 Xe --
55 Cs 0.7	56 Ba 0.9	57-71 --- 1.1-1.2	72 Hf 1.3	73 Ta 1.5	74 W 1.7	75 Re 1.9	76 Os 2.2	77 Ir 2.2	78 Pt 2.2	79 Au 2.4	80 Hg 1.9	81 Tl 1.8	82 Pb 1.8	83 Bi 1.9	84 Po 2.0	85 At 2.2	86 Rn --
87 Fr 0.7	88 Ra 0.9	89-- -- 1.1--															

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IONIZATION POTENTIALS OF THE ELEMENTS

(in electron volts)

1 H 13.6																2 He 24.6
3 Li 5.4	4 Be 9.3											5 B 8.3	6 C 11.3	7 N 14.5	8 O 13.6	9 F 17.4	10 Ne 21.6
11 Na 5.1	12 Mg 7.6											13 Al 6.0	14 Si 8.1	15 P 11.0	16 S 10.4	17 Cl 13.0	18 Ar 15.8
19 K 4.3	20 Ca 6.1	21 Se 6.6	22 Ti 6.8	23 V 6.7	24 Cr 6.8	25 Mn 7.4	26 Fe 7.9	27 Co 7.9	28 Ni 7.6	29 Cu 7.7	30 Zn 9.4	31 Ga 6.0	32 Ge 8.1	33 As 10	34 Se 9.8	35 Br 11.8	36 Kr 14.0
37 Rb 4.2	38 Sr 5.7	39 Y 6.6	40 Zr 7.0	41 Nb 6.8	42 Mo 7.2	43 Tc ---	44 Ru 7.5	45 Rh 7.7	46 Pd 8.3	47 Ag 7.6	48 Cd 9.0	49 In 5.8	50 Sn 7.3	51 Sb 8.6	52 Te 9.0	53 I 10.4	54 Xe 12.1
55 Cs 3.9	56 Ba 5.2	*	72 Hf 5.5	73 Ta 6	74 W 8.0	75 Re 7.9	76 Os 8.7	77 Ir 9.2	78 Pt 9.0	79 Au 9.2	80 Hg 10.4	81 Tl 6.1	82 Pb 7.4	83 Bi 8	84 Po --	85 At --	86 Rn 10.7
87 Fr --	88 Ra 5.3	†															

*	57 La 5.6	58 Ce 6.9	59 Pr 5.8	60 Nd 6.3	61 Pm --	62 Sm 5.6	63 Eu 5.7	64 Gd 6.2	65 Tb 6.7	66 Dy 6.8	67 Ho --	68 Er --	69 Tm --	70 Yb 6.2	71 Lu 5.0
†	89 Ac --	90 Th --	91 Pa --	92 U 4	93 Np --	94 Pu --	95 Am --	96 Cm --	97 Bk --	98 Cf --	99 Es --	100 Fm --	101 Md --	102 (?) --	

NOTE: Ionization energy in kcal/mole is 23.1 x electron volts.

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STANDARD OXIDATION POTENTIALS FOR HALF-REACTIONS

Ionic concentration, 1M in Water at 25°C

All ions are aquated

	HALF-REACTION	E° (volts)	
Very strong reducing agents	$Li \rightarrow e^- + Li^+$	3.00	Very weak oxidizing agents
	$Rb \rightarrow e^- + Rb^+$	2.92	
	$K \rightarrow e^- + K^+$	2.92	
	$Cs \rightarrow e^- + Cs^+$	2.92	
	$Ba \rightarrow 2e^- + Ba^{+2}$	2.90	
	$Sr \rightarrow 2e^- + Sr^{+2}$	2.89	
	$Ca \rightarrow 2e^- + Ca^{+2}$	2.87	
	$Na \rightarrow e^- + Na^+$	2.71	
	$Mg \rightarrow 2e^- + Mg^{+2}$	2.37	
	$Al \rightarrow 3e^- + Al^{+3}$	1.66	
	$Mn \rightarrow 2e^- + Mn^{+2}$	1.18	
	$H_2(g) + 2OH^- \rightarrow 2e^- + 2H_2O$	0.83	
	$Zn \rightarrow 2e^- + Zn^{+2}$	0.76	
	$Cr \rightarrow 3e^- + Cr^{+3}$	0.74	
	$H_2Te \rightarrow 2e^- + Te + 2H^+$	0.72	
	$2Ag + S^{-2} \rightarrow 2e^- + Ag_2S$	0.69	
	$Fe \rightarrow 2e^- + Fe^{+2}$	0.44	
	$H_2(g) \rightarrow 2e^- + 2H^+ (10^{-7}M)$	0.414	
	$Cr^{+2} \rightarrow e^- + Cr^{+3}$	0.41	
	$H_2Se \rightarrow 2e^- + Se + 2H^+$	0.40	
	$Co \rightarrow 2e^- + Co^{+2}$	0.28	
	$Ni \rightarrow 2e^- + Ni^{+2}$	0.25	
	$Sn \rightarrow 2e^- + Sn^{+2}$	0.14	
	$Pb \rightarrow 2e^- + Pb^{+2}$	0.13	
	$H_2(g) \rightarrow 2e^- + 2H^+$	0.00	
	$H_2S(g) \rightarrow 2e^- + S + 2H^+$	—0.14	
	$Sn^{+2} \rightarrow 2e^- + Sn^{+4}$	—0.15	
	$Cu^+ \rightarrow e^- + Cu^{+2}$	—0.15	
	$SO_2(g) + 2H_2O \rightarrow 2e^- + SO_4^{-2} + 4H^+$	—0.17	
	$Cu \rightarrow 2e^- + Cu^{+2}$	—0.34	
	$Cu \rightarrow e^- + Cu^+$	—0.52	
	$2I^- \rightarrow 2e^- + I_2$	—0.53	
	$H_2O_2 \rightarrow 2e^- + O_2(g) + 2H^+$	—0.68	
	$Fe^{+2} \rightarrow e^- + Fe^{+3}$	—0.77	
	$NO_2(g) + H_2O \rightarrow e^- + NO_3^- + 2H^+$	—0.78	
	$Hg(l) \rightarrow 2e^- + Hg^{+2}$	—0.78	
	$Hg(l) \rightarrow e^- + \frac{1}{2}Hg_2^{+2}$	—0.79	
	$Ag \rightarrow e^- + Ag^+$	—0.80	
	$H_2O \rightarrow 2e^- + \frac{1}{2}O_2(g) + 2H^+ (10^{-7}M)$	—0.815	
	$NO(g) + 2H_2O \rightarrow 3e^- + NO_3^- + 4H^+$	—0.96	
	$Au + 4Cl^- \rightarrow 3e^- + AuCl_4^-$	—1.00	
	$2Br^- \rightarrow 2e^- + Br_2(l)$	—1.06	
	$H_2O \rightarrow 2e^- + \frac{1}{2}O_2(g) + 2H^+$	—1.23	
	$Mn^{+2} + 2H_2O \rightarrow 2e^- + MnO_2 + 4H^+$	—1.28	
	$2Cr^{+3} + 7H_2O \rightarrow 6e^- + Cr_2O_7^{-2} + 14H^+$	—1.33	
	$2Cl^- \rightarrow 2e^- + Cl_2(g)$	—1.36	
	$Au \rightarrow 3e^- + Au^{+3}$	—1.50	
Very weak reducing agents	$Mn^{+2} + 4H_2O \rightarrow 5e^- + MnO_4^- + 8H^+$	—1.52	Very strong oxidizing agents
	$2H_2O \rightarrow 2e^- + H_2O_2 + 2H^+$	—1.77	
	$2F^- \rightarrow 2e^- + F_2(g)$	—2.87	

Reducing strength increases

Oxidizing strength increases

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CHEMISTRY ACHIEVEMENT TEST --

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